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Environmental Remediation Project of Cunha Baixa Mining Area
Cost Benefit Analysis

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Abstract

In the present time it has been growing a conscience about environmental problems. In this project it is intended to perform a Cost Benefit Analysis (CBA) of a specific environmental problem: Uranium mining exploration. The selected project was the Environmental Remediation of Cunha Baixa's Mining Area. From this CBA it will be possible to understand the economic reliability of this sort of project using one criteria of efficiency. The CBA performed show a wide variety of interpretations given the assumptions made, becoming clear the great impact that Human decisions can have.

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1. Introduction

In the present time it has been growing a conscience about environmental problems creating the need to understand them better and find a way to solve or at least minimize them. The case of mining exploration is no exception since there are negative impacts depending on the type of exploration that have been done. New legislation in Portugal, Decree Law no. 198-A/2001 of 6th July, appeared to try to minimize the impacts of mining exploration and especially to solve the problem that comes after it, what happens to the areas where there was extraction.

The Uranium mines were explored in Portugal between the years of 1907 and 2001 being "Empresa Nacional de Urânio" the last entity responsible for it. The different techniques used created several environmental impacts, more specifically in the waters, soils, air and landscape.

In this project it is intended to perform a Cost Benefit Analysis (CBA) of a specific case, the project of Environmental Remediation of Cunha Baixa's Mining Area. All the information presented in order to perform it is collected from the Environmental Impact Study (EIS) and Project Description both performed by COBA unless stated otherwise. From this CBA it will be possible to understand the economic reliability of this sort of project using one criteria of efficiency.

It is also important to see that a tool like CBA also have its weaknesses and since it takes into consideration efficiency by seeing if there is room for Pareto improvement it will not take into consideration equity issues.

The problem of equity will also try to be explored in this project and try to understand if in the specific case of Cunha Baixa what criteria should be used, efficiency or equity.

2. Project Description

2.1 Geographical and Historical Context

The most important Portuguese Uranium deposits of the 20th are located in the region of Beira Alta and they started being explored since 1907 for the production of radio and later for the exploration of uranium. The mining area of Cunha Baixa was discovered by the Junta de Energia Nuclear (that does not operate in the present time) in the year of 1957 and it is located in the district of Viseu, county of Mangualde and parish of Cunha Baixa.

The works of mining recognition started in 1967 and the subterranean exploitation was made between 1970 and 1987. The main open sky exploration started in the year of 1971 followed by more three and finished in 1991.

From both takedowns there was extraction of a Uranium compound that amounted to approximately 901 tons.

Also between the periods of 1983 and 1993 there was also static leaching in situ of H_2SO_4 in both types of works and the main purpose was the recuperation of the mineralization of the poorest areas of the takedown. The methods used in this mining process were the major contributors for the contamination of the waters, especially the subterranean, and it was obtained from this process 76 tons of U_3O_3. Another consequence of it was the acidification of the waters existent after the mining area.

2.2 Objectives of the Project

The project of environmental remediation that is proposed searches the solution of the following problems leading to the benefits referred further.

1st - There are big volumes of acid effluents that need treatment and control;

2nd - There is a need of control physically the communication between the underground hydro resources, the surface ones and their respective influences;

3rd - The dimension, morphology and nature of the waste dumps and old mud deposits that exist;

4th - The dimension of the cuts that result from the open sky exploration;

5th - The relations that exist between the open sky area and the mine;

6th - The fact that there were used methods of acid leashing for the extraction of the ore created that the water in the mines is really acid (a ph under 3);

7th - The proximity to the population of Cunha Baixa causes concerning to their public health.

It is important to mention that there is no evidence that the populations' health is being affected but, in the current situation, there is risk since there is absolute no control.

When solving the problems described above the effects will be a better quality of the water, rehabilitation of the soils and landscape and increase in the population well being by decreasing the risk of health problems due to contaminations.

The solution of problems one to three and also six makes possible the use of the water for irrigation (around 86% of water use in the area), and problems four and five will induce to the landscape and soil rehabilitation.

2.3 Project Definition

The Cunha Baixa's mines are included in the list of Uranium mines that are recognized as public interest for public intervention. The nearest population is the parish of Cunha Baixa and has a population of around one thousand people. This parish is located at a distance of one hundred meters of the mines.

The project of environmental remediation consists in a series of constructions and cleanings that will have the duration of two years. Within the project it is important to create a distinction between two processes, the remediation and the post remediation process. The need for this separation is due to the fact that different impacts will derive from the two processes referred. During the remediation process negative impacts will appear due to the movements and constructions and it is only after the remediation that the so called benefits will appear.

The first part of the project can be separated in nine different construction phases and they are described as the following:

- Phase 0: pumping test in open sky I and complementary geotechnical prospecting. It is also necessary to dimension in a definitive form the flow of the pumping to install. All the works are destined to obtain information about the conditions.

- Phase 1: preparation of the open sky IV and surrounding area for the deposition of sludge, waste dump materials, material from the areas to clean up and demolition residuals. Sealing of mining galleries, creation of landfills and collocation of a basal clay layer to seal the bottom.

- Phase 2: removal of the material coming from the sludge deposits to the deposition cell at the open sky IV. Execution of the side cuts sealing system.

- Phase 3: cleaning of the sanitizing areas. Continuation of the side cuts sealing system.

- Phase 4: total removal of the waste dumps, the sanitized materials due to the high radiometry and from the resulting products of the demolition of old buildings to the deposition cell at the open sky IV. Conclusion to the side cut sealing system.

- Phase 5: conclusion of the sealing of the open sky IV with a waterproofing system of double layer and improvement of the existent paths.

- Phase 6: Construction of the well pumping in the area of the old mining well number 9 and construction of the damping basin at the area of open sky I. Sealing of old wells and chimneys.

- Phase 7: Construction of the new MWTP. Model the waste dumps and treatment of open skies II and III. Waterproofing of the remaining opens skies.

- Phase 8: Close down of the existing MWTP. Landscaping works and sealing the intervention area.

In the second part of the project, more specifically, after the construction of the Mining Water Treatment Plant (MWTP) it is possible to start seeing the positive impacts, i.e., environmental benefits of the project. There is a cost here of control and observation.

3. Baseline

3.1 Soil

In this section it is intended to describe the soils presented in the mining area and the ones that are affected by the project. For it a brief description of their general characteristics and use capacity is given and then presented in **table 1**.

The study area is characterized by presenting two types of soils, the ones presented in greater quantities being dominant in the area of study that are the classified as “Udorthent” and there are also the presence of soil of the type “Fluvic” that appear in the valley of “Ribeira do Castelo”.

According to the usage capacity it is possible to say that most of the soils are classified as unfit for agricultural and pasture purposes or with really severe limitations being especially fit for wild and forestry vegetation. From them we can distinguish the ones that exist near the water lines that can be used for low intensive agriculture.

	Mining Area	Outside Mining Area
Type	Udorthent	Udorthent and Fluvic
Area (ha)	17	42
Use Capacity	Ee	Cs, De
	Forest	Limited Agriculture
Type of Intervention	Direct	Indirect

Table 1 – Soil Characteristics

In respect to the contamination of the soils it is possible to say that the major source is the water that comes from the mining area and not only flows near agricultural lands but also it is illegally used for irrigation purposes. Besides the mining area it is possible to see contamination near “Ribeira da Cunha Baixa” almost till it reaches “Ribeira do Castelo”.

The soils present inside the mining area do not have a purpose of agricultural usage, since their characteristics do not allow it. The other soils are going to be decontaminated in an indirect way, this is, through the cleaning of the waters and it is predicted that, in a medium run they will be decontaminated, given that the owners of the lands comply with some restrictions of usage.

3.2 Water

This section reflects one of the most import resources in the study because it has effects over the remaining, with the exception of the air. The waters are distinguished in three different types: superficial, given by two waterlines; groundwater that are given by water wells; and underground given by piezometer pairs and “boreholes”. Another important aspect is the fact that underground waters in the area come from infiltration making that it is possible to recover them when the water lines will be treated.

The reference for the water quality is the values predicted by the decree law no. 236/98 for irrigation purposes. In this decree law two different references are assumed, the maximum admissible value and the recommended admissible value. In **table 2** it is presented in which tests the water passed.

		Superficial	**Groundwater**	**Underground**
	Quantity (m^2/year)	291000		
Quality	**Maximum Admissible Value**	Yes	NO	NO
	Recommended Admissable Value	NO	NO	NO
	Radioctive	NO	NO	NO

Table 2 – Water Characteristics

The reference for the radioactive levels is based on the American Normative since the Portuguese legislation does not predict this kind of contamination

3.2.1 Superficial Water

The superficial waters are in two water lines, one that is temporary, this is, during the hot periods it gets completely dry and another one that is not. The analysis made to the two water lines is very similar in terms of quality and because of that they are treated as one.

Although all the tests are inside the maximum admissible values they are not in the recommended ones and this translates into a limited usage. Also the levels for

radiations, in the case tested especially for Radio and Uranium always pass the value that is predicted for usage by the American Normative.

3.2.2 Groundwater and Underground waters

The ground and underground waters did not pass in almost every sample that was taken the quality levels predicted by the Portuguese legislation and also the American normative. Since these waters in the region appear by infiltration the reason that appears to be more precise about the poorest quality of these waters compared to the water in the water lines is due to the fact that the soils are contaminated and when this process of infiltration occurs they absorb the waste that are present in the soils of the mine, not only the radioactive waste, but also, due to the type of exploration that was used, static leashing, also the acid.

3.3 Air

The global air quality of the region is given by the "Air Quality Index (IQar)" as so as the data collected from "Fundão's Station" since it is the one in the region that best reflects characteristics of the region. This index is given by an arithmetic average of the measured pollutants, in this case Carbon Monoxid (CO), Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), Ozone (O_3) and fine particles or inhalable. The index will vary from **Very Good** to **Bad** of each pollutant.

Global Air Quality	
Very Good	22.31%
Good	58.17%
Medium	16.73%
Weak	2.39%
Bad	0,40%

Table 3

A characterization of the area of study is presented in order to understand the real effects of it and the contamination that exists due to the mines. First of all it is given by **table 4**, the concentration

of radon in the Cunha Baixa's Mining area and after, making possible to understand the values given a comparison with another area with uranium mines but where there were no mining activities is done (**table 5)**.

Place	SPP2 cps (min-max)	SPP2 cps (average)	Radon Bq.m^{-3} (min-max)	Radon Bq.m^{-3} (average)
Waste Dump	450-550	483	110-175	152
Open Sky and surrounding area	300-1250	733	110-195	146
Muds	ND	2500	ND	570
Perifery	220-250	235	75-85	80

Table 4

Effective added dosis	CA (mSv/year)
PARTIAL	
External Radiation	0,93
Radon	0,24
Water	0,1
Agriculture products	0,18
TOTAL	1,45

Table 5

From **table 5** it is possible to understand taking into account that the maximum admissible value is 1 mSv/year that in the Cunha Baixa's mines this value is passed by almost by 50%. This means that inside the mining area the reference values admissible for a rural population are being passed and it is not admissible that people would live or go there in the present time.

It is also important to take into account that the mining area is inside a region where the air quality is considered majorly **Good** and **Very Good** according to the IQar index.

3.4 Socio Economic Aspects

In this section it is intended to characterize the population that lives near the area of study and compare it, every time it is possible to the population of Portugal. Also it is intended to precise as best as possible to the region that is more affected, in this case Cunha Baixa's parish. The data is presented in **table 6**.

		Portugal	Mangualde	Cunha Baixa
Population	1981	9833014	21438	
	1991	9867147	21808	1276
	2001	10356117	20990	1133
Mortality Rate	2005	9,8	8,7	
Natality Rate	2005	9,4	12	
Unemployment	1991	6,1%	5,1%	
	2001	6,7%	4,4%	
Economic Activities	Primary Sector	5,0%	7,1%	
	Secondary Sector	35,1%	44,8%	
	Terciary Sector	59,9%	48,1%	

Table 6

As it is possible to see the population in the last 10 years has been decreasing and ageing, since the mortality rate is higher than the birth rate. When looking to the unemployment and type of economic activities we can see that the unemployment rates are lower than the national ones, but respect to economic activities the values for the Primary and Secondary sectors are higher than the ones of Portugal.

4. Costs

The costs associated to this project are mainly financial and according to the Environmental Impact Study (EIS) all the negative impacts of the project are not globally significant and with the appropriate measures of control they can be attenuated. Because these control measures are considered in the project these costs are included in the financial analysis.

The financial costs can be separated in eleven different parts, each of them with different purposes. The information relative to the financial costs is all presented in **table 7**.

	Designation	Value
1.	Yard	250.000,00 €
2.	Preparatory Works	221.466,88 €
3.	Modeling	1.309.422,00 €
4.	Sealing and Coverage Systems	2.477.022,50 €
5.	Drainage	1.069.661,69 €
6.	Mechanic and Electromechanical equipment	260.221,00 €
7.	Electric installations and automation system	57.700,00 €
8.	Recuperations and integration of the landscape	548.147,80 €
9.	Access	90.832,20 €
10.	Mine Water Treatment Plant (MWTP)	655.461,62 €
11.	Control and Observation	3.000,00 €
	TOTAL	6.942.935,69 €

Table 7 – Project Costs

5. Benefits

The benefits that we can take from the project are environmental benefits making that they are non market goods (with the exception of the agricultural lands).

In order to evaluate the benefits of the project a need to create a base scenario appeared since there is uncertainty about the results due to the fact that some of them will depend on the choices of the population that lives near the mining area.

In the base scenario several assumptions are made and this would be the best scenario that could happen from the project. The assumptions that are made are that the population will comply with all the restrictions that will be made to their agricultural activities in the medium run making that in the deadline of 15 years the soils around the mining area will be completely decontaminated and also that in the present do not exist any sort of agricultural activities or at least that the ones that exist are made in a low scale being only for their own consumption and do not enter the market of food.

Another assumption is made referring the time frame of the project, this is since there is a natural decontamination process the project impact will be considered only during the time that would take for the decontamination to happen naturally. In the EIS there is no reference for the time that it would take being stated that only a high long term would take to clear the area. For sake of simplicity it is assumed that it would take the time of a generation, this is, according to the Portuguese life expectancy, 82 years.

5.1 Soil

The area affect by the intervention directly is characterized, as referred in the baseline by soil suitable for forest land growing and the impact of the project according to the EIS is considered positive.

The value used for evaluating this impact was the one used as reference by “Gabinete Técnico Florestal” of “Câmara Municipal de Mangualde”. This reference refers to the lands that can’t be used for agricultural purposes being only fit for the growing of wild vegetation.

The reference value for this sort of land is 5000€ per hectare making that the total value of the decontamination of the soils inside the mining area is equal to 85000€.

5.2 Water

The valuation of the water is made based on its future purpose, in this case for irrigation. The main reason for only considering this purpose is because there is no evidence that the water, after the intervention, can be used for any other purpose as it was referred in the baseline. By other words, all the standards of quality that this project aims for it to comply with the national index for irrigation waters presented in the decree law no. 236/98.

To do so it was used the methodology of revealed preferences, using the prices of the land from another location with similar characteristics. The location chosen was “Oliveira do Hospital” and the main reason for it was because it shares the same type of soils and also because it has Uranium mines but that have never been explored given not only a very good reference for the prices comparison but also it is very useful to understand the impact of the human activities during the mining exploration in Cunha Baixa.

All the data was gathered from local real estate agencies. At this point it is important to refer that in both regions due to the size of the populations the real estate business is made by the owners or by local agencies. Another important aspect to refer is the limitation of the data since the land for sale is not very abundant.

It was necessary to filter the collected data trying to distinguish which lands had an agricultural purpose and which ones did not. When looking to the data it was possible to take that the average price for an agricultural land where there is presence of water is 2,07€ per square meter and without 0,63€. From these prices it was possible to take an approximate value for the decontamination of the lands of the difference between the two, 1,44€/m^2.

The value of the water will reflect the increase in prices from the base scenario; this is as if no water would be available. As it was said before the increase in prices due to the presence of water is equal to 1,44€/m^2 making that the total value of the decontamination of the water is equal to 606867,84€.

5.3 Ecological and landscape impact

The ecological and landscape impact is given not only by the fact that the wastes will be clean and the vegetation growing will be arranged but especially by the fact that after

the intervention the air quality will increase substantially and it will be possible to go to the mining area. It is intended in the project that the mining area will became a picnic park.

The evaluation of the this impact is based on the usage that the population could give to it and, based on that, the value will be given taking into account the value of time if the population of the area.

From the "National Institute of Statistics" (INE) it was possible to take the income of the people that work in each sector. The average monthly incomes of each sector are 551€, 703€ and 821€ in the primary, secondary and tertiary sectors respectively. Given distribution of the population in each sector (referred in the baseline) it is possible to compute and average monthly salary $0{,}071 \times 551 + 0{,}448 \times 703 + 0{,}481 \times 821 = 748{,}97€$. From here we can take that the average salary per minute will be 0,07€.

In order for an element of the population to go between the center of the village to the center of the mining area it takes between 10 to 15 minutes.

Here a new assumption is made, and that is that the entire population of Cunha Baixa will go to this park once a year. The main reason for this assumption is because it does not exist in the village any kind of place for outdoor activities so it is reasonable to assume that it will be used. Because the population is constituted by more elderly people the time used to arrive to the park will be the maximum that was referred, this is 15 minutes making that if someone would like to go there it will take 30 minutes to go and come back.

Given the assumption made it is possible to evaluate this impact of the project of $\int_0^{1133} 2{,}1 dx = 2379{,}30€$ per year.

5.4 Health Risk

When accounting for the risk to the health of the population due to the mining activities one of the assumptions that were made in the base scenario will be relaxed. In this section it is considered that agricultural production exists. The effects of the exposition to the radiation through food are going to be accounted.

First it is important to distinguish between the two types of radiation exposition that exist, chronic and acute, and in the case the one that reflects better the situation is chronic. Chronic exposition considers small amounts of radiation during long periods of time and according to the US Nuclear Regulatory Commission the estimate of the probability of developing a fatal cancer is 1 in 2500, this is 0,04%. It is important to refer that this probability is value with big uncertainty since there several exogenous factors that can affect it like food habits, smoking and propensity to develop cancers and also because of the difficulty to distinguish between normal cancers and the ones that are due to the radiation.

In order to attribute a value to this risk, the value of a statistical life (VSL) considered by the European Union (DG Environment) was used, this is 1,4 million euro (prices of 2000). Because all of the remaining values are in 2011 prices an actualization of the value was made making that the VSL is equal to 1801178,04€.

From here it is possible to take willingness to pay of eliminating this risk, that is the product between the VSL and the probability of occur a cancer that is 720,47€. This value means that each element of the population should be willing to pay 560€ in order to eliminate the probability to have cancer.

Due to the impossibility of calculating the exact value of the population that is being exposed to radiation new assumptions were made, this is an interval is considered. The

interval goes from the population of Cunha Baixa to all the population of Mangualde. These two levels of population are referred in the results section as 2nd and 3rd scenarios respectively. A higher interval is not considered since the level of potential production could not reach more population.

6. Results

The benefits that come from the project can be unpredictable since they depend on the Human interaction after the development of the same. Because of this, in this section several hypotheses will be presented in order to try to cover the most possible situations that can come from it. The hypotheses made are the ones referred in the benefits section as base, 2nd and 3rd scenarios.

In the EIS it is said that the contamination of the soils that are affected indirectly depend on the fact that people restrict their agricultural activities for a medium term. This is a strong assumption since people, in the present time use the waters that are contaminated for irrigation purposes even though they are informed that they are not proper for it and it is illegal to do so.

The discount rate that was used to compute the values is 4,3% and the reason for this choice was since all the benefits of the project are environmental it would make sense to use a rate that normally is used to environmental problems, in this case the rate suggested by Nordhaus to compute the prices of carbon emissions.

A time line is introduced based on the fact that natural decontamination (without Human intervention) can occur. Although that is not referred in the EIS the exact time that would take for this natural decontamination to occur it is referred that it can happen

in a high long term, and for sake of simplicity it is considered the life time of an average person in Portugal, this is 82 years.

Given the base scenario that was referred in the benefits section, it is possible to compute the Economic Net Present Value of the project testing it for economic efficiency. The values used for this computation are given by **table 8**.

Looking to them it is possible to see that the project does not pass the test of efficiency having a negative ENPV of 6481632,98€.

		Base Scenario
Financial Costs	**Price**	**Present Value**
Yard	250.000,00 €	250.000,00 €
Preparatory Works	221.466,88 €	221.466,88 €
Modeling	1.309.422,00 €	1.309.422,00 €
Sealing and Coverage Systems	2.477.022,50 €	2.477.022,50 €
Drainage	1.069.661,69 €	1.069.661,69 €
Mechanic and Electromechanical equipment	260.221,00 €	260.221,00 €
Electric installations and automation system	57.700,00 €	57.700,00 €
Recuperation and integration of landscape	548.147,80 €	548.147,80 €
Access	90.832,20 €	90.832,20 €
Mine Water Treatment Plant (MWTP)	655.461,62 €	655.461,62 €
Control and Observation	3.000,00 €	3.000,00 €
TOTAL	6.942.935,69 €	6.942.935,69 €
Environmental Benefits		
Soil	85.000,00 €	85.000,00 €
Water	606.867,84 €	322.722,69 €
Ecological and Landscape	2.379,30 €	53.580,02 €
Health Risk	0,00 €	0,00 €
TOTAL	694.247,14 €	461.302,71 €
ENPV		**-6.481.632,98 €**

Table 8 – Results of Base Scenario

As it was referred, in order to evaluate the other scenarios, some assumptions are relaxed and a new benefit is introduced, the reduction of the risk of the population that now will not take the value of zero.

		2nd Scenario	3rd Scenario
Financial Costs	**Price**		
Yard	250.000,00 €	250.000,00 €	250.000,00 €
Preparatory Works	221.466,88 €	221.466,88 €	221.466,88 €
Modeling	1.309.422,00 €	1.309.422,00 €	1.309.422,00 €
Sealing and Coverage Systems	2.477.022,50 €	2.477.022,50 €	2.477.022,50 €
Drainage	1.069.661,69 €	1.069.661,69 €	1.069.661,69 €
Mechanic and Electromechanical equipment	260.221,00 €	260.221,00 €	260.221,00 €
Electric installations and automation system	57.700,00 €	57.700,00 €	57.700,00 €
Recuperation and integration of landscape	548.147,80 €	548.147,80 €	548.147,80 €
Access	90.832,20 €	90.832,20 €	90.832,20 €
Mine Water Treatment Plant (MWTP)	655.461,62 €	655.461,62 €	655.461,62 €
Control and Observation	3.000,00 €	3.000,00 €	3.000,00 €
TOTAL	6.942.935,69 €	6.942.935,69 €	6.942.935,69 €
Environmental Benefits			
Soil	85.000,00 €	85.000,00 €	85.000,00 €
Water	606.867,84 €	322.722,69 €	322.722,69 €
Ecological and Landscape	2.379,30 €	53.580,02 €	53.580,02 €
Health Risk	720,47 €	816.293,89 €	15.122.690,82 €
TOTAL	694.247,14 €	1.277.596,59 €	15.583.993,53 €
ENPV		**-5.665.339,10 €**	**8.641.057,84 €**

Table 9 – Results of 2nd and 3rd Scenarios

As it is possible to see, when accounting the value of the health risk the results have a great variation, being this variable the one with higher significance. The second and third scenarios reflect an interval of population that can be affected by the project and when accounting for all the population of Mangualde the project becomes efficient having a ENPV of 8641057,84€. Because of the Magnitude of the interval (going from

1133 to 20990 people) the quantity of the population will be subject to a sensitivity analysis in order to be possible to understand the significance of one extra person be added to the effects of the project.

7. Sensitivity Analysis

7.1 Base Scenario

7.1.1 Water

The best possible outcome value for the water of 606867,84€ per year was established, or if based on the current prices of the lands, people would be willing to pay more 1,44€ per square meter in order to have access to water.

In order to be possible a non negative result considering the give assumptions it would be necessary that people would be willing to pay more 30,47€ per square meter in order to have access to clean water.

7.1.2 Ecological and Landscape Impact

In the base scenario the price considered for the landscape impact is equal to 2,10€ per person and per year, meaning that each person is willing to pay this amount to be able to use the park assuring not only a better visual impact but also the air quality in the area.

In order to the project have a positive value this value would have to increase till 251,80€ per person and per year otherwise, given everything else constant the project value would be negative.

7.1.3 Discount Rate

When testing the value of the project sensitivity to the discount rate first it is checked which value of this rate would have to be for this project to be positive. The discount rate would need to be equal to be negative (-5,78%) in order for the project be efficient.

From this result we can see that the influence of the discount rate does not have significance in the project, meaning that only if the future was valued higher than the present, under the assumptions made the project could be positive.

7.2 2nd and 3rd Scenarios

7.2.1 Health Risk

The health risk represents a variable that has a great impact in the results. First, given the VSL, the project would be efficient if it 8996 people could be affect by the exposition to radiation, this is consumed products that are produced in the surroundings of the mining area.

In the second scenario the price attributed to the health risk would need to rise till 5720,77€ for the ENPV to be positive. This means that VSL would need to be equal to 14301926,26€ that is not reasonable value. Looking to the third scenario, since the project is positive it was calculated the minimal willingness to pay of the population for the ENPV remain positive that is the value of 308,80€. This value reflects a VST of 771990,59€ much lower than the one suggested by the European Union making that under the used assumptions the project would be an efficient measure.

7.2.2 Discount Rate

The discount rate variations only make sense to analyze under the perspective of the third scenario, since in the second the values do not differ significantly from the base scenario. In the third scenario it is interesting to see that even using a discount rate that tends to infinity, valuing only the present, the project would be positive.

8. Conclusion

The CBA performed show a wide variety of interpretations given the assumptions made, becoming clear the great impact that Human decisions can have. It can be seen when comparing the results with and without the assumption of no agricultural production (as it is recommended).

The variable with greater impacts was the one accounting for the health risk of the population, given that all the others have really local effects not being able to justify the costs associated with a project of this magnitude. And even so, this variable, as it was said before only exists given some assumptions, this is, that people do not respect or are not properly informed, of the appropriate conduct to have facing this sort of situation.

In a situation where all the recommendations and restrictions are being followed by the population there is no justification for the project but in the case where it does not happen or an investment in control and information would be advisable (instead of the project) or if it would not be possible then the project starts to make sense to exist achieving efficiency depending on the quantity of people that can be affected.

However, given the conditions of uncertainty it can make sense for the development of the project in order to reduce this uncertainty and secure the safety of the local populations.

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